Electrically-Active Convection and Tropical Cyclogenesis in the Atlantic and East Pacific

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It has been hypothesized that deep, intense convective-scale “hot” towers may aid the process of tropical cyclogenesis and intensification through dynamic and thermodynamic feedbacks on the larger meso-to-synoptic scale circulation. In this study, we make use of NCEP Reanalysis data and Tropical Rainfall Measurement Mission (TRMM) lightning imaging sensor (LIS), precipitation radar (PR), and microwave imager (TMI) data to investigate the role that widespread and/or intense lightning-producing convection (i.e., “electrically-hot towers”) present in African easterly waves (AEWs) may play in tropical cyclogenesis over the Atlantic, Caribbean, and East Pacific regions.

NCEP Reanalysis 700 hPa meridional winds for the months of June to November for the years 2001–2009 were analyzed for the domain of 5ºN–20ºN and 130ºW–20ºE in order to partition individual AEWs into northerly, southerly, trough, and ridge phases. Subsequently, information from National Hurricane Center (NHC) storm reports was used to divide the waves into developing and non-developing waves. In addition, information from the NHC reports was used to further divide the developing waves into those waves that spawned storms that only developed to tropical storm strength and those that spawned storms that reached hurricane strength. The developing waves were also divided by the region in which they developed. To assess the evolution of convection associated with the AEWs as they propagated across our analysis domain, the full 130ºW–20ºE domain was divided into five longitude bands, and waves were analyzed for each band. To help determine the gross nature of the smaller convective scale, composites were created of all developing and non-developing waves as a function of AEW wave phase over the full analysis domain and each longitude band by compositing TRMM PR, TMI, LIS, and IR brightness temperature data extracted from the NASA global-merged infrared brightness temperature dataset. Finally, similar composites were created using various NCEP variables to assess the nature of the larger scale environment and circulation.

Results suggest a clear distinction between developing and non-developing waves as developing waves near their region of development in terms of the intensity of convection (indicated by lightning flash rate), coverage of cold cloudiness (indicated by the percentage of a 2.5° by 2.5° box covered by IR brightness temperatures less than 240 K and 210 K), and large-scale variables, such as midlevel moisture and upper-level upward motion. For example, waves that developed in the East Pacific longitude band (i.e., 130ºW–95ºW) were observed in that band to have a flash rate of 56.4 flashes day^{-1}, a coverage by brightness temperatures less than 240 K equal to 15.9%, a coverage by

brightness temperatures less than 210 K equal to 2.2%, a 700-hPa specific humidity anomaly of 0.4 g kg^{-1}, and a 300-hPa omega value of -0.04 Pascals s^{-1} in the trough phase compared to the non-developing wave trough values of 22.1 flashes day^{-1}, a coverage by brightness temperatures less than 240 K equal to 8.1%, a coverage by brightness temperatures less than 210 K equal to 0.9%, a 700-hPa specific humidity anomaly of -0.3 g kg^{-1}, and a 300-hPa omega value of -0.01 Pascals s^{-1}. Further analysis is being conducted to determine if the aforementioned behavior is observed for developing waves farther from their region of development and to determine any significant differences between waves that spawned storms that reached tropical storm strength and those that spawned storms that reached hurricane strength.